FIG 1

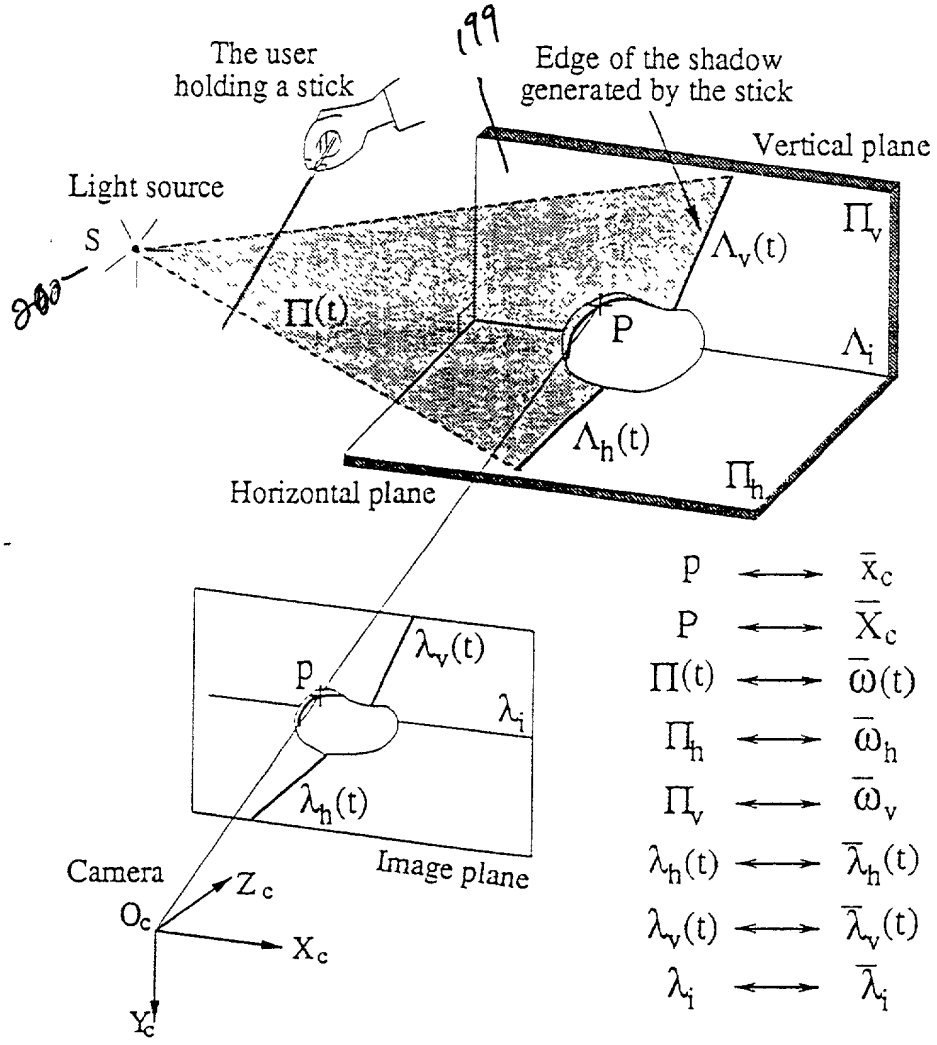

199
The user holding a stick
Edge of the shadow generated by the stick
Vertical plane
Light source
S
200
Π_v
$\Lambda_v(t)$
$\Pi(t)$
P
Λ_i
$\Lambda_h(t)$
Π_h
Horizontal plane
p
$\lambda_v(t)$
λ_i
$\lambda_h(t)$
Image plane
Camera
Z_c
O_c
X_c
Y_c
$p \longleftrightarrow \bar{x}_c$
$P \longleftrightarrow \bar{X}_c$
$\Pi(t) \longleftrightarrow \bar{\omega}(t)$
$\Pi_h \longleftrightarrow \bar{\omega}_h$
$\Pi_v \longleftrightarrow \bar{\omega}_v$
$\lambda_h(t) \longleftrightarrow \bar{\lambda}_h(t)$
$\lambda_v(t) \longleftrightarrow \bar{\lambda}_v(t)$
$\lambda_i \longleftrightarrow \bar{\lambda}_i$

FIG. 2

300 — Calibration - find Π_H position

305 — obtain Image of the shadow
1) shadow time t_s at each pixel
2) locate projections

310 — Convert projections (λ) into actual shadow info (Λ)

315 — Find shadow plane

320 — Find $P \alpha X_c$ by triangulation

FIG 3

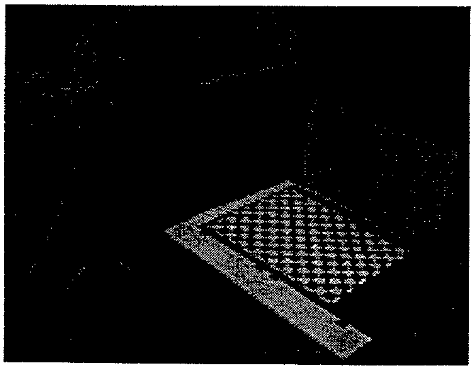


FIG 4A

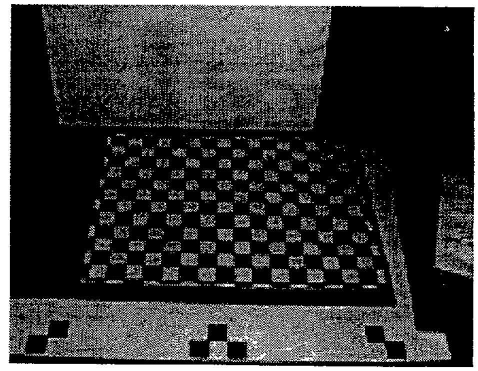


FIG 4B

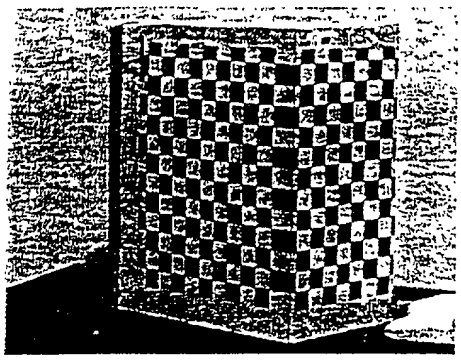


FIG. 5

FIG. 6A

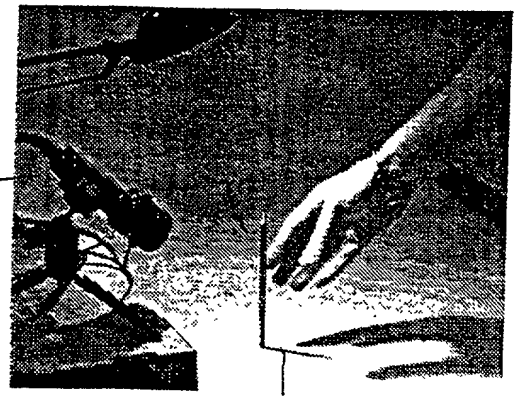
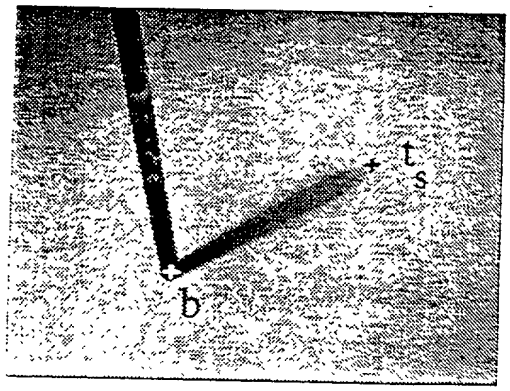


FIG. 6B



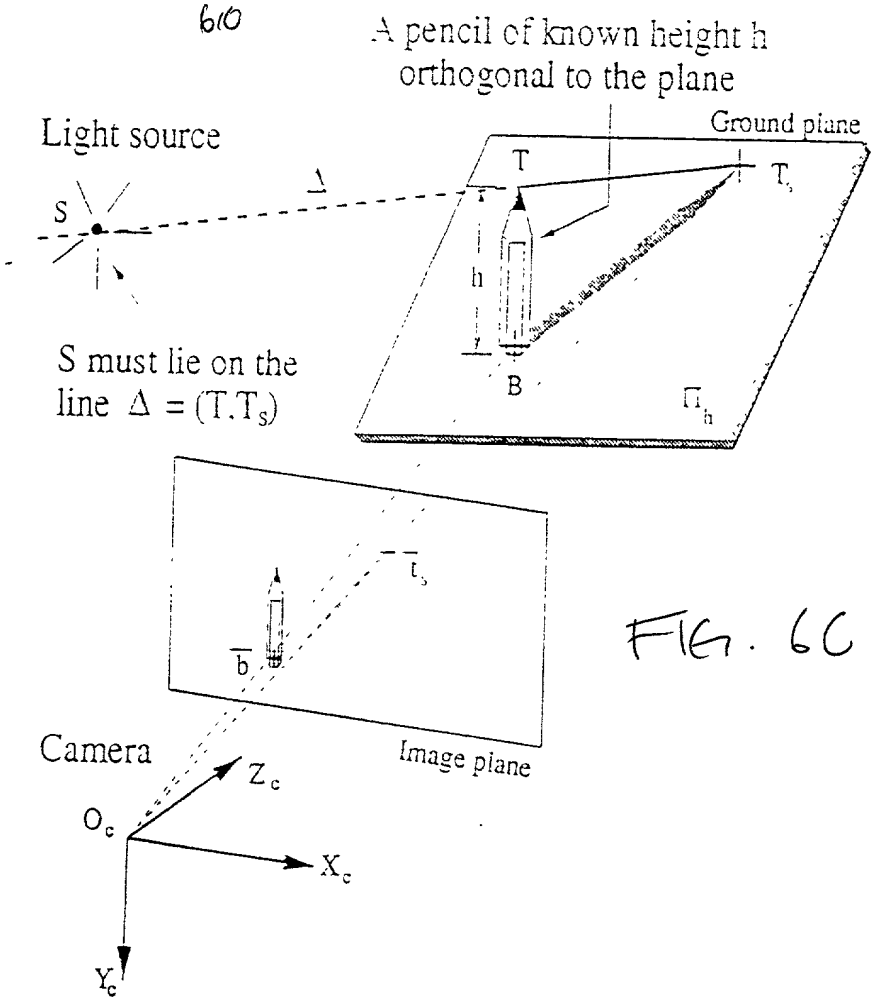


FIG. 6C

Fig. 7

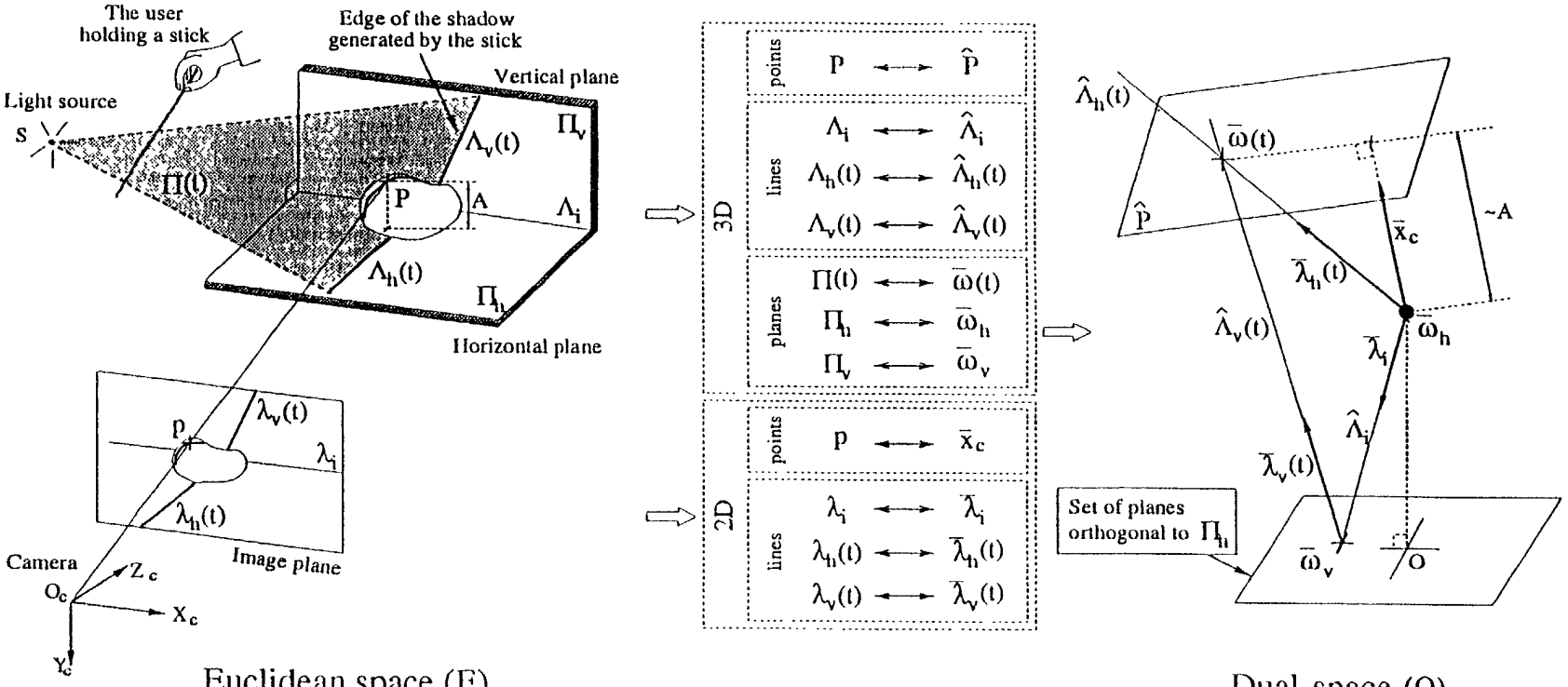
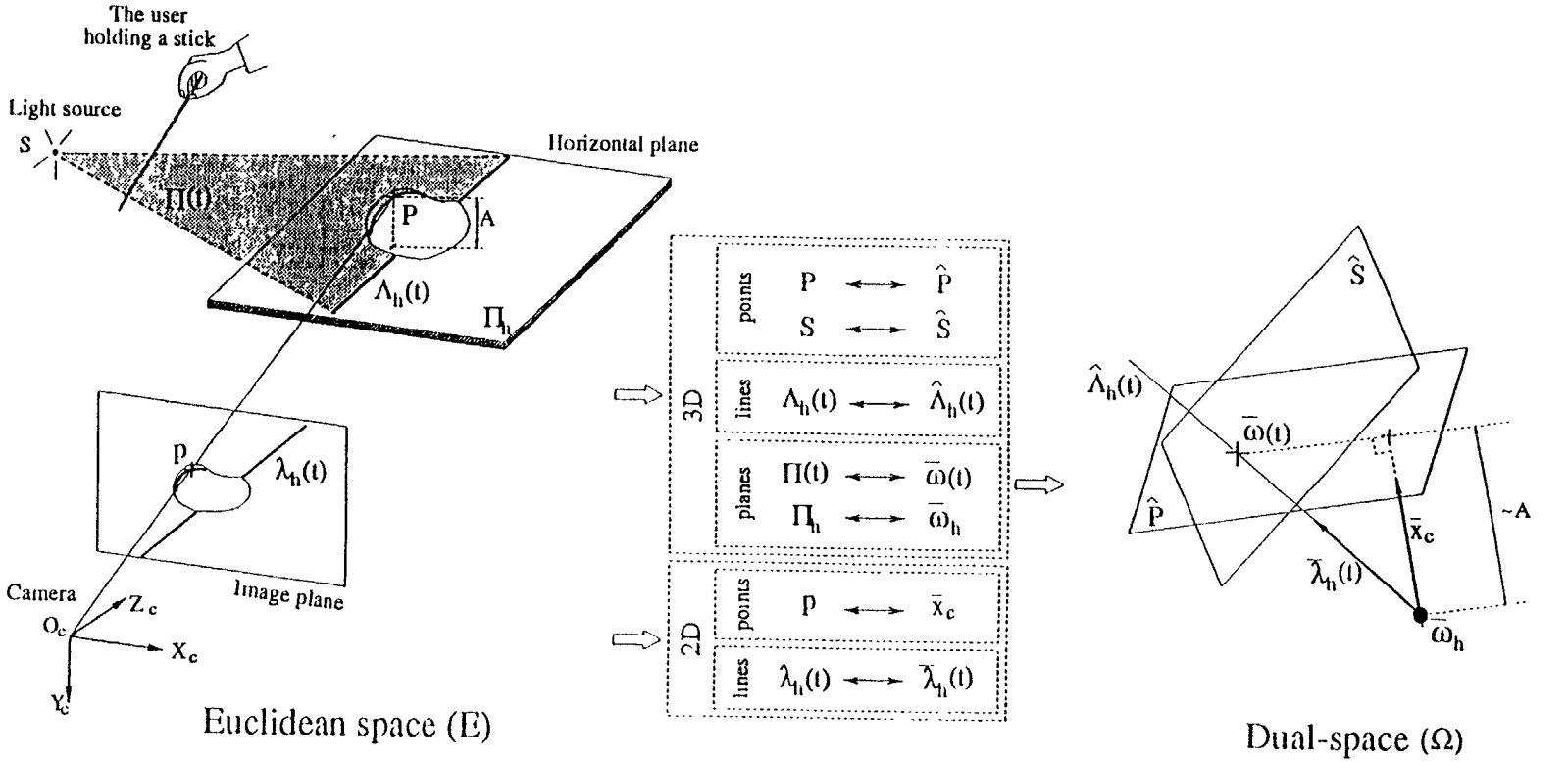

The user holding a stick
Edge of the shadow generated by the stick
Light source
S
Vertical plane
Π_v
$\Lambda_v(t)$
$\Pi(t)$
P
A
Λ_i
$\Lambda_h(t)$
Π_h
Horizontal plane
p
$\lambda_v(t)$
λ_i
$\lambda_h(t)$
Image plane
Camera
O_c
Z_c
X_c
Y_c
Euclidean space (E)
3D
points
$P \leftrightarrow \hat{P}$
lines
$\Lambda_i \leftrightarrow \hat{\Lambda}_i$
$\Lambda_h(t) \leftrightarrow \hat{\Lambda}_h(t)$
$\Lambda_v(t) \leftrightarrow \hat{\Lambda}_v(t)$
planes
$\Pi(t) \leftrightarrow \bar{\omega}(t)$
$\Pi_h \leftrightarrow \bar{\omega}_h$
$\Pi_v \leftrightarrow \bar{\omega}_v$
2D
points
$p \leftrightarrow \bar{x}_c$
lines
$\lambda_i \leftrightarrow \bar{\lambda}_i$
$\lambda_h(t) \leftrightarrow \bar{\lambda}_h(t)$
$\lambda_v(t) \leftrightarrow \bar{\lambda}_v(t)$
$\hat{\Lambda}_h(t)$
$\bar{\omega}(t)$
$\hat{P}$
$\bar{x}_c$
~A
$\bar{\lambda}_h(t)$
$\hat{\Lambda}_v(t)$
$\bar{\omega}_h$
$\bar{\lambda}_i$
$\hat{\Lambda}_i$
$\bar{\lambda}_v(t)$
Set of planes orthogonal to Π_h
$\bar{\omega}_v$
O
Dual-space (Ω)

FIG. 8


The user holding a stick
Light source
S
Horizontal plane
Π(t)
P
A
Λh(t)
Πh
p
λh(t)
Camera
Oc
Zc
Xc
Yc
Image plane
Euclidean space (E)
3D
points
P ⟷ P̂
S ⟷ Ŝ
lines
Λh(t) ⟷ Λ̂h(t)
planes
Π(t) ⟷ ω̄(t)
Πh ⟷ ω̄h
2D
points
p ⟷ x̄c
lines
λh(t) ⟷ λ̄h(t)
Λ̂h(t)
Ŝ
ω̄(t)
P̂
x̄c
~A
λ̄h(t)
ω̄h
Dual-space (Ω)

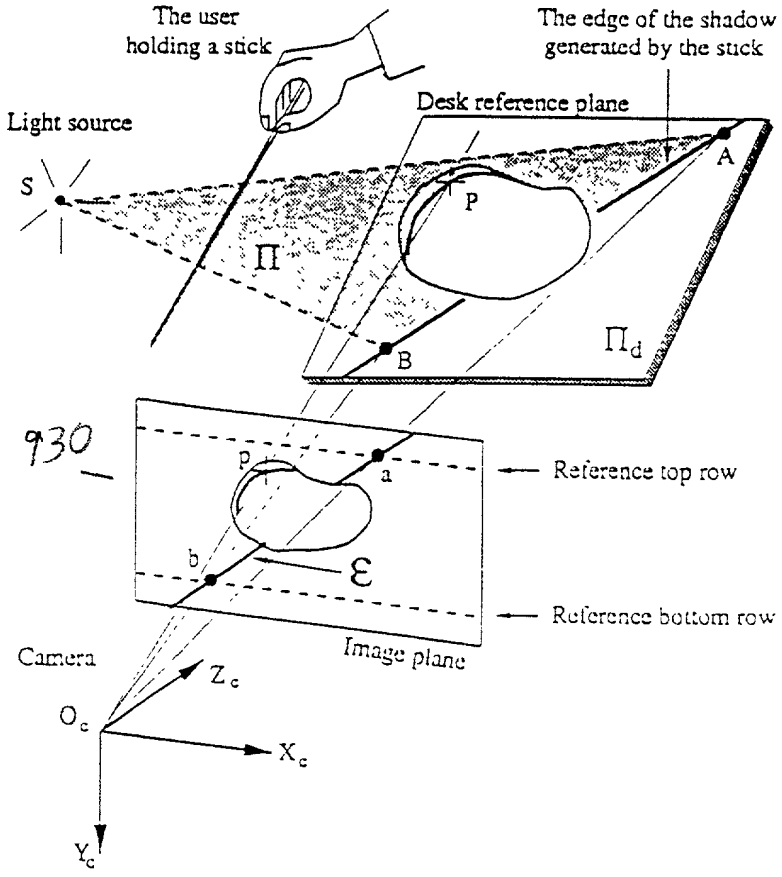

The user
holding a stick
The edge of the shadow
generated by the stick
Desk reference plane
Light source
S
A
P
Π
B
Π_d
930
p
a
Reference top row
b
ε
Reference bottom row
Camera
Image plane
Z_c
O_c
X_c
Y_c

FIG.9

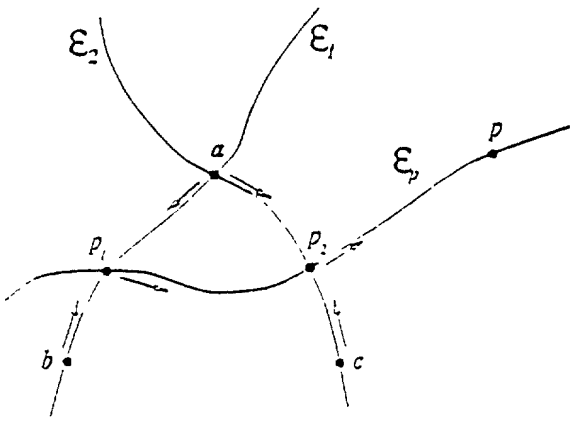


FIG. 10

successive steps:

1120

1130

1140

Step 1:	Acquire a set shadow images, extract the shadow edges and compute their intersections.
Step 2:	Reject all isolated edges (and isolated groups of edges) so that the entire edge-web is fully connected (def. 2). Results a set of N edges $\mathcal{E}_i$, and N_p intersection points p_k.
Step 3:	Build the $2N \times 2V$ matrix $\mathbf{C}$ (eq. 7.10, 7.11 and 7.12), and compute the unitary seed vector $\overline{U}^o$ by SVD. Euclidean reconstruction is then achieved up to the three scalars α, β and γ.
Step 4:	Select (at least) three points in the scene with known depths, and solve linearly for the remaining scalars α, β and γ (eq. 7.13).
Step 5:	Compute the list of shadow plane vectors $\overline{\omega}_i$ (eq. 7.7 and 7.2) and triangulate all the points in the edge-web. The resulting set of 3D points may then be triangulated into a surface mesh for visualization purposes (fig. 7.5 and 7.6).

FIG. 11

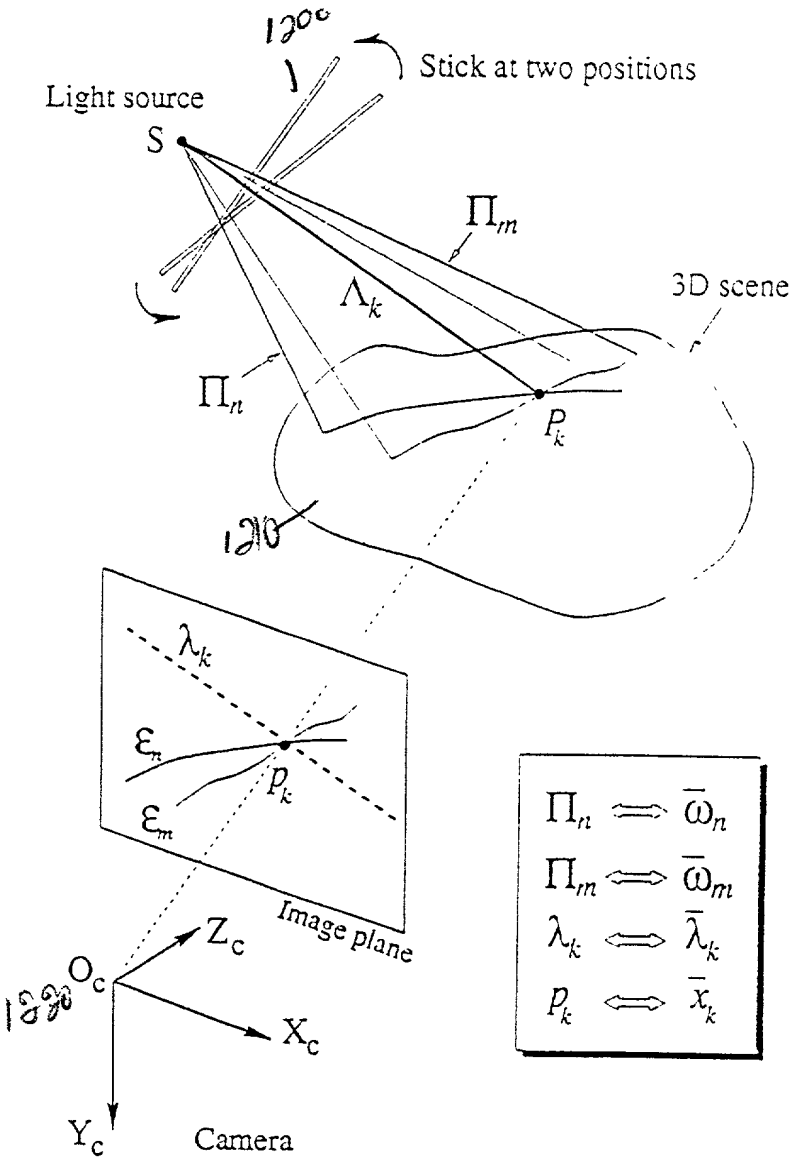

1200
Stick at two positions
Light source
S
Π_m
Λ_k
3D scene
Π_n
P_k
120
λ_k
ε_n
p_k
ε_m
Image plane
Z_c
O_c
X_c
Y_c
Camera
$\Pi_n \Longleftrightarrow \bar{\omega}_n$
$\Pi_m \Longleftrightarrow \bar{\omega}_m$
$\lambda_k \Longleftrightarrow \bar{\lambda}_k$
$p_k \Longleftrightarrow \bar{x}_k$

FIG. 12

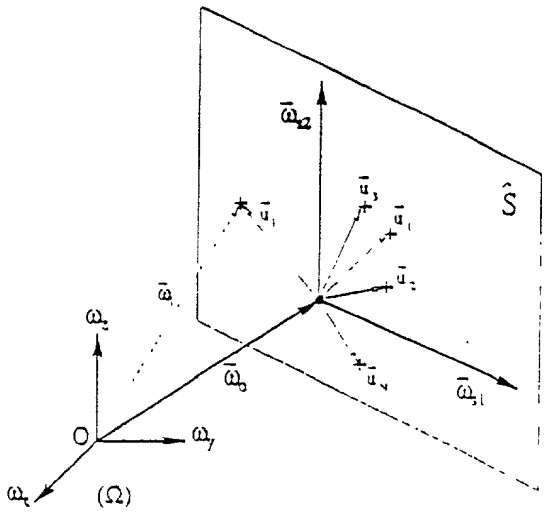

$\bar{\omega}_{z1}$
$\hat{S}$
$\bar{\omega}_z$
$\bar{\omega}_3$
$\bar{\omega}_{y1}$
O
ω_y
ω_x
(Ω)

FIG. 13

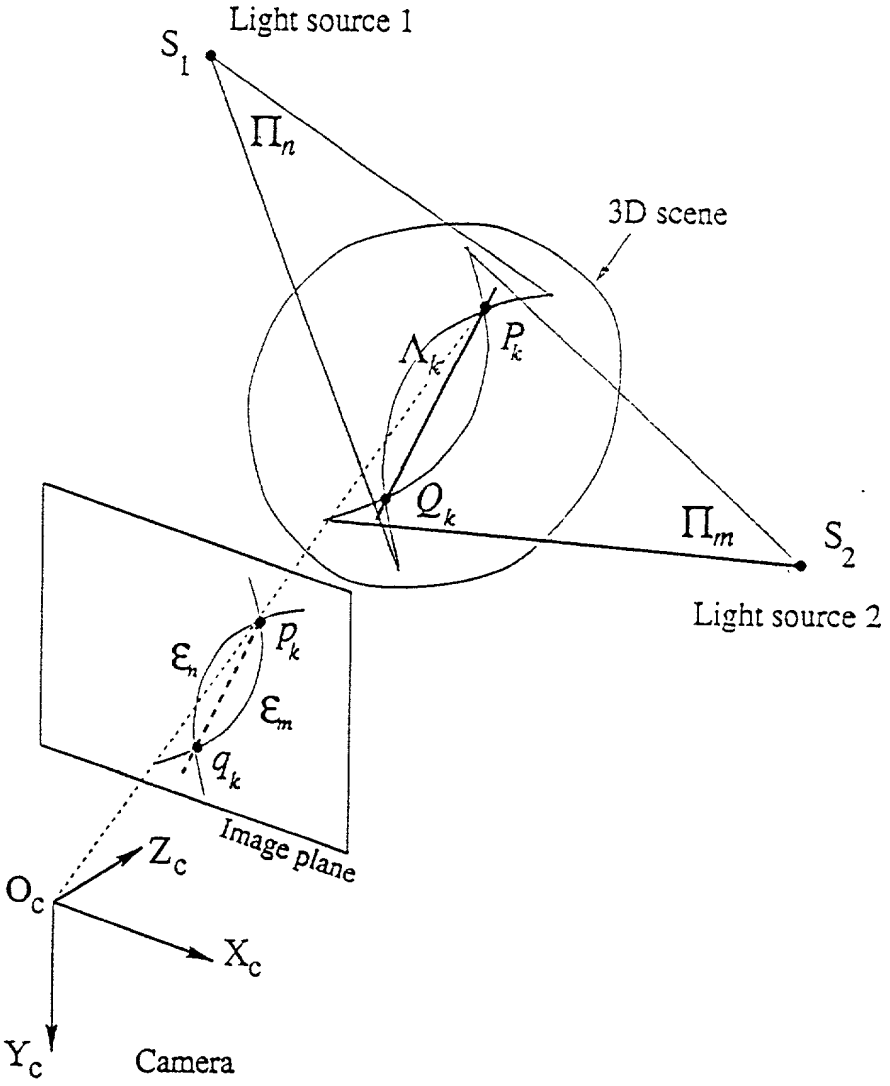

Light source 1
S_1
Π_n
3D scene
Λ_k
P_k
Q_k
Π_m
S_2
Light source 2
ε_n
$\bar{p}_k$
ε_m
q_k
Image plane
Z_c
O_c
X_c
Y_c
Camera

FIG. 14

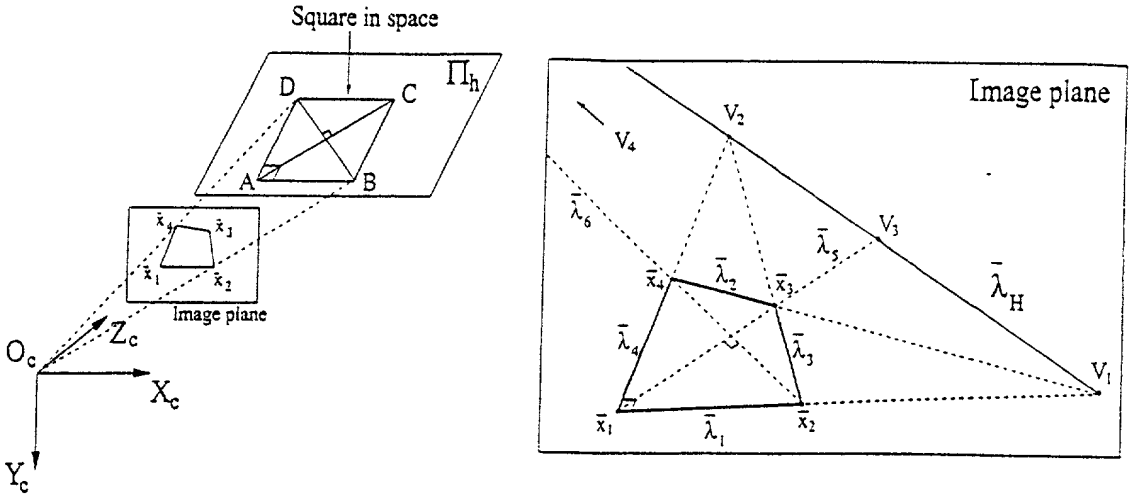

Square in space
Π_h
D
C
A
B
Image plane
O_c
Z_c
X_c
Y_c
Image plane
V_4
V_2
V_3
V_1
$\bar{\lambda}_H$

FIG. 15

FIG. 16